CLAIMS

We claim:

1. A ceramic nanocomposite, comprising:

a substantially amorphous matrix of non-oxide ceramic phase; and

a nanoscale dispersion of crystalline oxide phases in said substantially amorphous matrix.

2. A ceramic nanocomposite according to claim 1 wherein said non-oxide ceramic phase includes a silicon atom, a carbon atom, and a nitrogen atom.

3. A ceramic nanocomposite according to any of claims 1 and 2 wherein said crystalline oxide phases include crystalline oxide phases from the group consisting of zirconia, alumina, spinels, and oxides of iron.

4. A ceramic nanocomposite according to any of claims 1 and 2 wherein said crystalline oxide phases include a perovskite.

5. A ceramic nanocomposite according to any of claims 1 and 2 wherein said crystalline oxide phases include a piezoelectric material.

6. A ceramic nanocomposite according to any of claims 1 and 2 wherein said crystalline oxide phases include a dielectric material.

7. A method for producing a nanocomposite ceramic fiber, comprising steps of:

providing a primary precursor, said primary precursor being a precursor of a non-oxide ceramic;

mixing a secondary precursor with said primary precursor to form an intermediate mixture, said secondary precursor being a precursor of an oxide ceramic;

heating said intermediate mixture to a viscous state;

drawing said viscous intermediate mixture into a fiber;

thermosetting said fiber into a rigid state; and

pyrolyzing said fiber to form a nanocomposite fiber comprising a nanophase distribution of said oxide ceramic within said non-oxide ceramic.

8. A method as in claim 7 wherein said thermosetting is performed at a temperature above 160°C.

9. A method for producing a nanocomposite fiber according to claim 7

wherein said oxide ceramic is a metal oxide ceramic and said secondary precursor is an organo-metallic precursor of said metal oxide ceramic.

10. A method for producing a nanocomposite fiber according to claim 7 wherein said non-oxide ceramic contains a silicon atom, a carbon atom, and a nitrogen atom.

11. A method for producing a nanocomposite fiber according to claim 7 wherein said oxide ceramic contains atoms selected from groups III and IV of the periodic system of the elements or transition metals or lanthanoid metals and oxygen.

12. A method for producing a nanocomposite fiber according to claim 7 wherein said oxide ceramic contains a zirconium atom and an oxygen atom.

13. A method for producing a nanocomposite fiber according to claim 7 wherein said primary precursor does not have any temperature to make it viscous for drawing fiber, has a first thermosetting temperature, and has a first pyrolyzing temperature, and wherein said secondary precursor has a first drawing temperature to make it viscous for fiber drawing, has a second thermosetting temperature, and has a second pyrolyzing temperature; wherein a mixture of said primary and secondary precursors has a second drawing temperature to make it viscous for drawing fiber, has a third thermosetting temperature close to said second drawing temperature, and a third pyrolyzing temperature.

14. A nanocomposite ceramic fiber, comprising:

a non-oxide ceramic; and

a nanophase distribution of an oxide ceramic within said non-oxide ceramic.

15. A nanocomposite ceramic fiber according to claim 14 wherein said non-oxide ceramic is amorphous.

16. A nanocomposite ceramic fiber according to claim 14 wherein said oxide ceramic is amorphous.

17. A nanocomposite ceramic fiber according to claim 14 wherein said non-oxide ceramic contains a silicon atom, a carbon atom, and a nitrogen atom.

18. A nanocomposite ceramic fiber according to claim 14 wherein said oxide ceramic contains atoms selected from groups III and IV of the periodic system of the elements or transition metals or lanthanoid metals and oxygen.

19. A nanocomposite ceramic fiber according to claim 14 wherein said oxide ceramic contains a zirconium atom and an oxygen atom.

20. A method for making a ceramic nanocomposite magnet, comprising steps of:

mixing a ferrite powder in a polymeric precursor of silicon carbonitride to obtain a liquid precursor dispersion mixture;

crosslinking said liquid precursor dispersion mixture into an interim solid body;

powdering said interim solid body into an interim powder;

pelletizing said interim powder into an interim pellet; and

pyrolyzing said interim pellet into a nanocomposite of silicon carbonitride and ferrite.

21. A method for making a ceramic nanocomposite magnet according to claim 20 wherein said mixing is carried out with an ultrasonic bath.

22. A method for making a ceramic nanocomposite magnet according to claim 20 wherein said crosslinking step includes heating said liquid precursor dispersion mixture to at least approximately 400°C.

23. A method for making a ceramic nanocomposite magnet according to claim 21 wherein said crosslinking step includes heating said liquid precursor dispersion mixture to at least approximately 400°C.

24. A method for making a ceramic nanocomposite magnet according to claim 20 wherein said pelletizing step includes heating and compressing said interim powder in a pellet-shaped mold mixing.

25. A method for making a ceramic nanocomposite magnet according to claim 20 wherein said mixing step mixes said liquid precursor dispersion mixture to have a nanocomposite composition of approximately 70% ferrite and 30% silicon carbonitride, by volume.

26. A method for making a ceramic nanocomposite magnet according to claim 20 wherein said mixing comprises mixing said liquid precursor dispersion mixture to have a nanocomposite composition of substantially 70% ferrite and 30% silicon carbonitride, by volume.

27. A method for making a ceramic nanocomposite magnet according to claim 20 wherein said mixing step mixes said ferrite powder and polymeric precursor of silicon carbonitride in a ratio such that said nanocomposite of silicon carbonitride and ferrite has a coercivity approximately two orders of magnitude less than a coercivity of a ferrite magnetic material.

28. A method for making a ceramic nanocomposite magnet according to claim 20 wherein said mixing comprises mixing said ferrite powder and polymeric precursor of silicon carbonitride in a ratio such that said nanocomposite of silicon carbonitride and ferrite has a coercivity substantially two orders of magnitude less than a coercivity of a ferrite magnetic material.

29. A method for making a ceramic nanocomposite magnet according to claim 20 wherein said crosslinking step includes heating said liquid precursor dispersion mixture to at least approximately 400°C in a nitrogen atmosphere.

30. A method for making a ceramic nanocomposite magnet according to claim 20 wherein said crosslinking includes heating said liquid precursor dispersion mixture to at least approximately 400°C in a nitrogen atmosphere.

31. A method for making a ceramic nanocomposite magnet according to claim 20 wherein said pyrolyzing includes heating said pellet to a temperature of approximately 1000°C.

32. A method for making a ceramic having a predetermined coefficient of thermal expansion, said method comprising:

providing a primary precursor, said primary precursor being a precursor of a non-oxide ceramic having a first coefficient of thermal expansion;

mixing a secondary precursor with said primary precursor to form an intermediate mixture, said secondary precursor being a precursor of an oxide ceramic having a second coefficient of thermal expansion;

thermosetting intermediate mixture into an intermediate material; and

pyrolyzing said intermediate material to form a nanocomposite ceramic comprising a nanophase distribution of said oxide ceramic within said non-oxide ceramic,

wherein said mixing comprises mixing said secondary precursor and said

primary precursor in a ratio such that said nanocomposite ceramic has said predetermined coefficient of thermal expansion.

33. A method for making a ceramic having a predetermined coefficient of thermal expansion according to claim 32 wherein said oxide ceramic includes a zirconium atom.

34. A method as in claim 32 and further including:

providing a substrate;

prior to said step of pyrolyzing, applying said intermediate mixture or said intermediate material to said substrate; and

wherein said mixing comprises mixing said secondary precursor and said primary precursor in a ratio such that said nanocomposite ceramic has a coefficient of thermal expansion matched to said substrate.

35. A method as in claim 34 wherein said coefficient of thermal expansion is matched to said substrate at temperatures of 500°C or higher.

36. A method as in claim 34 wherein said substrate comprises a metallic or ceramic material.

37. A method as in claim 34 wherein said providing, mixing, applying, thermosetting, and pyrolyzing are repeated to provide a graded nanocomposite ceramic coating.

38. A ceramic coated structure, comprising:

a substrate; and

a ceramic nanocomposite coating comprising a crystalline oxide ceramic in a substantially non-oxide ceramic, said coating having a coefficient of thermal expansion to match said substrate.

39. The structure of claim 38 wherein said substrate is either metallic or ceramic.

40. The structure of claim 38 wherein said coating is a multilayer graded coating in which each layer has a different proportion of said crystalline oxide ceramic to said non-oxide ceramic.

41. The structure of claim 38 wherein said coating imparts resistance to corrosion at high temperatures.